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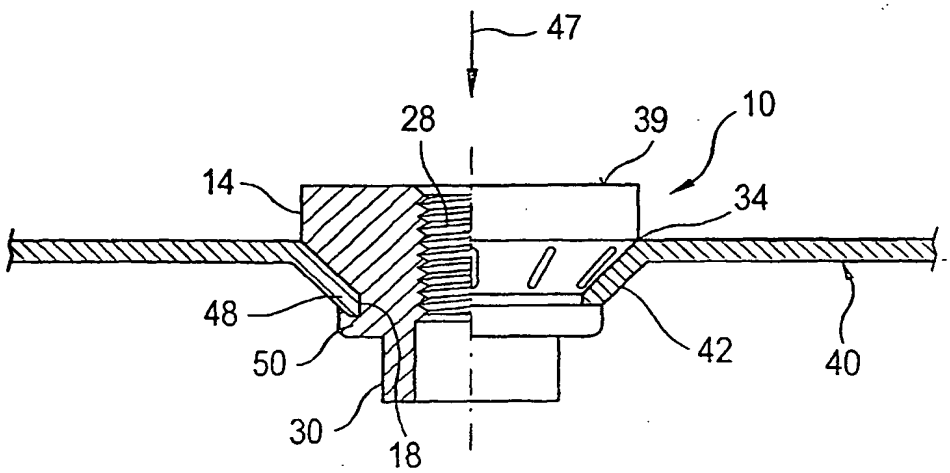
[Fortsetzung auf der nächsten Seite]

(54) Title: FUNCTIONAL ELEMENT FOR ATTACHING TO A SHEET METAL PART, COMPOSITE COMPONENT PRODUCED FROM SAID ELEMENT AND METHOD FOR ATTACHING THE FUNCTIONAL ELEMENT TO A SHEET METAL PART

(54) Bezeichnung: FUNKTIONSELEMENT ZUR ANBRINGUNG AN EIN BLECHTEIL, AUS DIESEN HERGESTELLTES ZUSAMMENBAUTEIL SOWIE VERFAHREN ZUR ANBRINGUNG DES FUNKTIONSELEMENTS AN EIN BLECHTEIL



(57) Abstract: The invention relates to a functional element for attaching to a sheet metal part, such as for example a nut element or a bolt element comprising a body section or head section, which has a requisite cylindrical part on one axial end and runs into a cylindrical rivet section on its other axial end. Said element is characterised in that the body section is provided with an essentially cone-shaped region between the first axial end or a cylindrical section that may be provided there and the rivet section, said region forming a bearing surface for a corresponding cone-shaped region of a sheet metal part and that the cylindrical part, if present, has a diameter at the border with the cone-shaped region that is no greater than the maximum diameter of said cone-shaped region. When the functional element is attached to the sheet metal part, the narrow end of the cone-shaped region of said metal part is clamped in an annular protrusion, formed by the rivet section. The invention also relates to and discloses a composite component and to a method for attaching a functional element.

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DECLARATION

I, James G. Morgan, a British subject of Markgrafenstr. 8, 81827 Munich, West Germany, do hereby declare that I am conversant with the English and German languages and that I am a competent translator thereof.

I verify that the attached English translation is a true and correct translation of the annex to the international preliminary examination report of April 19, 2002 in connection with the PCT application PCT/EP03/04075.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Signed:

James G. Morgan

this 3rd day of September 2004

Translation of Annex to International Preliminary Examination Report

Re. V
Justified finding with respect to novelty, inventive step and commercial utility; documents and explanations to support this finding.

Reference is made to the following document:

D4 DE 38 35 566 A (Profil Verbindungstechnik GmbH), May 11th , 1989

1. The subject of claim 1 is novel in the sense of the Art. 33(2) PCT since in none of the documents is a functional element described in which the circular cylindrical part at the boundary to the conical region had a diameter which is not larger than the maximum diameter of the conical region and thus does not form a ring flange there.

2. The document D4 is regarded as the closest piece of prior art with respect to the subject of claim 1. It discloses (the references in brackets relate to this document):

   A functional element for attachment to a sheet metal part having a body part or head part (Abstract) which has at its first axial end a circular cylindrical part and merges at its other axial end into a cylindrical rivet section (Fig. 4) with the body part being provided in the region between the first axial end and the rivet section with an at least substantially conical region, which forms a contact surface for a corresponding conical region of a sheet metal part (Fig. 4).

   The subject of claim 1 is thus distinguished from the known functional element in that the circular cylindrical part at the boundary to

the conical region has a diameter which is not larger than the maximum diameter of the conical region and thus does not form a ring flange there.

The object to be satisfied by the present invention can thus be seen in avoiding the formation of fatigue cracks in the sheet metal part.

The way of satisfying this object proposed in claim 1 of the present application relates to an inventive step (Art. 33(3) PCT) because the combination of features contained in independent claim 1 is neither known from the present prior art nor is it rendered obvious by it.

3. The independent claim 17 relates to a component assembly consisting of a functional element and a sheet metal part, with the functional element likewise containing the feature that the circular cylindrical part at the boundary to the conical region has a diameter which is not larger than the maximum diameter of the conical region and thus does not form a ring flange there. The subject of claim 17 is thus also novel and inventive.

4. The claims 2 to 16 and 18 to 31 (dependent on claims 1 to 17 respectively) thus likewise satisfy the requirements of the PCT with respect to novelty and inventive step.

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Functional element for the attachment to a sheet metal part, component assembly manufactured from this and also a method for the attachment of a functional element to a sheet metal part

The present invention relates to a functional element for attachment to a sheet metal part such as for example a nut element or a bolt element having a body part or head part respectively which has at its first axial end, if required, a circularly cylindrical part and which merges at its other axial end into a cylindrical rivet section, in accordance with the preamble of claim 1, and also relates to a component assembly manufactured from the functional element and a sheet metal part in accordance with the preamble of claim 17.

A functional element of the initially named kind is offered by the company Profil Verbindungstechnik GmbH & Co. KG, Friedrichsdorf, Germany, under the designation EMF in the form of a nut element. With this element a component can be attached to the side of the sheet metal part remote from the ring flange and indeed by means of a threaded bolt which engages into the thread of the nut element and clamps the component and the sheet metal part against one another. The element is attached to a sheet metal part by means of the method which is described in EP-A-0 713 982 in conjunction with its Figs. 16 and 17, with this method being claimed per se in the corresponding European Divisional Application EP-A-0 922 866. A functional element of the initially named kind in the form of a bolt element is likewise known and indeed in the form of a so-called SBF bolt element of the company Profil Verbindungstechnik GmbH & Co. KT which is described, amongst other things, in the German Patent 34 47 006 together the associated attachment method. Both the EMF

element and also the SBF element have proved themselves in practise. With the EMF element the sheet metal part is only insignificantly deformed and remains, in the region of attachment of the functional element, at least substantially in the same plane as the surrounding sheet metal material.

In contrast, with the SBF bolt, a rounded recess is produced in the sheet metal part and this leads to a relatively stiff attachment of the bolt element to the sheet metal part.

The object underlying the present invention is to provide a functional element which ensures a stiff attachment to the sheet metal part, so that tensile forces and compression forces and also transverse forces and shear forces can be transmitted via the element to the sheet metal part, with the attachment being intended to have a long working life even with alternating loading and not tending to the formation of fatigue cracks. Furthermore, the invention intends to provide a component assembly comprising the functional element and a sheet metal part which has corresponding characteristics and to make available a method for the attachment of the functional element which ensures a high quality attachment of the functional element to the sheet metal part without being particularly complicated in its realization. In addition, the functional element should be suitable for an electric terminal element, for example in the form of an earthing bolt.

In this application the designation "functional element" has its normal meaning, the examples for such functional elements are fastener elements such as nut elements and bolt elements which enable the attachment of a further component to a sheet metal part. The designation however also includes all other types of hollow elements which for example serve to

receive inserted parts or as a rotatable support for a shaft as well as all elements which are provided with a shaft part, for example to receive a clip or for the rotary mounting of a hollow part.

In order to satisfy the object a functional element of the initially named kind is provided in accordance with the invention which is characterized in that the body part is provided in the region between the first axial end, or any circularly cylindrically part provided there, and the rivet section with an at least substantially conical region which forms a contact surface for a corresponding conical region of a sheet metal part and in that the circularly cylindrical part, if present, has a diameter at the boundary to the conical region which is not larger than the maximum diameter of the conical region and thus does not form a ring flange there.

A corresponding component assembly is characterized in that the body part is provided in the region between the first axial end, or any circularly cylindrically part provided there, and the rivet section with an at least substantially conical region which forms a contact surface for a corresponding conical region of the sheet metal part and in that the circularly cylindrical part, if present, has a diameter at the boundary to the conical region which is not larger than the maximum diameter of the conical region and thus does not form a ring flange there, wherein a conical region of the sheet metal part is trapped in a ring bead formed from the rivet section and in that the conical region of the sheet metal part contacts the conical region of the functional element at least substantially over its full area.

This embodiment of the functional element, or of the component assembly formed with the functional element, thus leads to a formation in which the conical region of the sheet metal part contacts the conical region of the

body part of the functional element at least substantially over its full area. This construction provides a particularly stiff and firm attachment of the functional element of the sheet metal part and thus satisfies the subject of the object set out above.

This full area contact leads to a situation in which relative movements between the sheet metal part and the element are largely precluded. This also increases the stiffness of the connection and helps avoid the formation of fatigue cracks.

It is particularly favourable when features providing security against rotation are provided in the region of the conical surface since the sheet metal material can be brought into engagement with these features providing security against rotation, whereby the security against rotation is achieved without reducing the stiffness of the connection. The features providing security against rotation can, for example, advantageously have the form of noses and/or recesses.

The axial length of the conical surface should correspond at least approximately to twice the sheet metal thickness, preferably to approximately four times the sheet metal thickness. A dimension of this kind ensures that the conical region is adequately long in order to achieve the desired stiffness.

The enclosed cone angle of the conical surface preferably lies in the range between 60° and 150°. An enclosed cone angle in the range between 70° and 140° and in particular a cone angle of 75° to 150° is particularly preferred. An enclosed cone angle of approximately 90° counts as particularly preferred.

It is particularly favourable when the conical surface merges via a cylindrical neck part into the rivet section. This neck part is essentially not deformed during the deformation of the material of the functional element in the region of the rivet section and forms a part of the clamping recess for the sheet metal material in the region of the edge of the hole provided in the sheet metal material. The neck part can, with advantage, have an axial length which corresponds approximately to the sheet metal thickness and is preferably somewhat larger than this.

The axial height of the circularly cylindrical part can be reduced to zero so that the end face of the conical region with the largest diameter comes to lie at the surface of the sheet metal part remote from the rivet bead or lies somewhat higher or lower than this surface.

The possibility also exists however of making the axial thickness of the circular cylindrical part significantly larger than the thickness of the sheet metal part to which the element is to be secured. In this case the end face of the circularly cylindrical part remote from the sheet metal part projects significantly in front of the corresponding top side of the sheet metal part and can for example be exploited to realize a spacer function. In both cases the conical surface in the region of the side of the sheet metal part remote from the rivet bead can be executed with a relatively large diameter so that on the whole a large support surface is present between the functional element and the sheet metal part, whereby a favourable surface pressure is achieved and the transmission of forces via the functional element into the sheet metal part can be favoured. Particularly preferred embodiments of the functional element and also of the component assembly can be found in the subordinate claims.

The attachment of the functional element to a sheet metal part can take place amongst other things with a method which is essentially known from the German Patent 34 47 006, with the shape of the die being adapted to the special shape of the sheet metal part of the functional element.

The invention will be explained in more detail in the following with reference to embodiments and to the drawings which show:

Fig. 1 a functional element in the form of a nut element partly sectioned in the axial direction,

Fig. 2 a schematic representation of a sheet metal part which is prepared to receive the functional element of Fig. 1,

Claims

1. Functional element (10; 110) for attachment to a sheet metal part, such as for example a nut element (10) or a bolt element (110) having a body part (12; 112) or head part respectively which has at its first axial end, if required, a circularly cylindrical part (14; 114) and which merges at its other axial end into a cylindrical rivet section (20; 120), characterized in that
the body part (12; 112) is provided in the region between the first axial end, or any circularly cylindrically part provided there, and the rivet section (20; 120) with an at least substantially conical region (16; 116) which forms a contact surface for a corresponding conical region (42; 142) of a sheet metal part (40; 140) and in that the circularly cylindrical part, if present, has a diameter at the boundary (34; 134) to the conical region which is not larger than the maximum diameter of the conical region.

2. Functional element in accordance with claim 1,
characterized in that
features (38; 138) providing security against rotation are provided in the region of the conical surface (16; 116).

3. Functional element in accordance with any one of the preceding claims,
characterized in that
the axial length of the conical surface (16; 116) of the conical region corresponds at least approximately to twice the sheet metal thickness and preferably to approximately four times the sheet metal thickness.

4. Functional element in accordance with any one of the preceding claims,
characterized in that
the enclosed cone angle (α) of the conical surface of the conical region lies in the range between 60° and 150°, preferably in the range between 70° and 140° and in particular between 75° and 115° and amounts particularly preferably to about 90°.

5. Functional element in accordance with any one of the preceding claims,
characterized in that
the conical surface (16; 116) of the conical region merges via a cylindrical neck part (18; 118) into the rivet section (20; 120).

6. Functional element in accordance with claim 5,
characterized in that
the neck part (18; 118) has an axial length which corresponds at least approximately to the sheet metal thickness and is preferably somewhat larger than this.

7. Functional element in accordance with any one of the claims 2 to 6,
characterized in that
the features (38; 138) providing security against rotation have the form of noses which are provided at the conical surface (16; 116).

8. Functional element in accordance with claim 7,
characterized in that
the noses (38; 138) providing security against rotation extend in axial planes.

9. Functional element in accordance with claim 7 or claim 8, characterized in that
the noses (38; 138) providing security against rotation extend at the conical surface over at least substantially the axial length of the conical region.

10. Functional element in accordance with claim 7, characterized in that
the features providing security against rotation have the form of recesses provided in the conical surface.

11. Functional element in accordance with claim 10, characterized in that
the recesses forming the features providing security against rotation are arranged in axial planes of the functional element.

12. Functional element in accordance with any one of the preceding claims, characterized in that
the end face of the body part at its first axial end, i.e. at the end of the body part remote from the rivet section, or at the end face of any circularly cylindrical part (14; 114) provided there, forms a support surface for a component which is secured by means of the functional element (10; 110) to the sheet metal part (40; 140).

13. Functional element in accordance with claim 12, characterized in that
the axial thickness of the circularly cylindrical part (14) is selected in order to realize a spacer function between the sheet metal part (40)

and a component attached to the sheet metal part by means of the functional element (10).

14. Functional element in accordance with any one of the preceding claims,
characterized in that
it is a nut element (10) in which the body part (12) is provided with a central bore (26).

15. Functional element in accordance with any one of the preceding claims 1 to 13,
characterized in that
it is a bolt element (110) with a shaft part (113) which is arranged at the side of the body part (112) of the circularly cylindrical part (114) remote from the rivet section (120).

16. Functional element in accordance with any one of the preceding claims,
characterized in that
a plurality of noses providing security against rotation are provided at the conical region of the functional element, preferably extend over the full length of the conical region in axial planes and are preferably uniformly distributed around the longitudinal axis of the functional element.

17. Component assembly comprising a functional element such as a nut element (10) or bolt element (110), in particularly in accordance with one of the claims 1 to 6 having a body part (12; 112) or a head part which has at its first axial end, if required, a circularly cylindrical

part (14; 114) and which merges at its other axial end into a cylindrical rivet section (20; 120),
characterized in that
the body part (12; 112) is provided in the region between the first axial end, or any circularly cylindrically part provided there, and the rivet section (20; 120) with an at least substantially conical region (16; 116) which forms a contact surface for a corresponding conical region (42; 142) of the sheet metal part (40; 140) and in that the circularly cylindrical part, if present, has a diameter at the boundary to the conical region which is not larger than the maximum diameter of the conical region, wherein a conical region (42; 142) of the sheet metal part is trapped in a ring bead (50; 150) formed from the rivet section and in that the conical region (42; 142) of the sheet metal part contacts the conical region of the functional element at least substantially over its full area.

18. Component assembly in accordance with claim 17,
characterized in that
features (38; 138) providing security against rotation are provided in the region of the conical surface of the functional element and in that the sheet material of the sheet metal part (40; 140) in the conical region (42; 142) engages in form-fitted manner with the features providing security against rotation.

19. Component assembly in accordance with claim 17 or 18,
characterized in that
the axial length of the conical surface (16; 116) corresponds at least approximately to twice the sheet metal thickness and preferably to at least four times the sheet metal thickness.

20. Component assembly in accordance with any one of the preceding claims 17 to 19,
characterized in that
the included cone angle (α) of the conical surface (16; 116) lies in the range between 60° and 150°, preferably in the range between 70° and 140° and in particular between 75° and 115° and particularly preferably amounts to approximately 90°.

21. Component assembly in accordance with any one of the preceding claims 17 to 20,
characterized in that
the conical surface (16; 116) merges via an at least substantially cylindrically neck part (18; 118) into the rivet section (20; 120).

22. Component assembly in accordance with claim 21,
characterized in that
the neck part (20; 120) has an axial length which corresponds at least approximately to the sheet metal thickness and is preferably somewhat larger than this.

23. Component assembly in accordance with any one of the preceding claims 17 to 22,
characterized in that
it is a nut element (10) in which the body part (12) is provided with a central bore (26).

24. Component assembly in accordance with any one of the claims 17 to 23,
characterized in that

the ring bead (50) is formed by displacement of material of the rivet section (20).

25. Component assembly in accordance with any one of the claims 17 to 23,
characterized in that
the rivet section (120) is beaded over around the edge (148) of the opening (144) of the conical region (142) of the sheet metal part (140) to form the ring bead or a rivet bead.

26. Component assembly in accordance with any one of the claims 17 to 22 or 24 or 25,
characterized in that
the functional element is a bolt element which has a shaft part (113) having a thread which projects away from the end of the conical region of the body part (112) remote from the rivet bead or from any circularly cylindrical part (112) present there or from a projection provided at an end of the conical region of the body part (114) remote from the rivet bead or at the free end of a circular cylindrical part provided there.

27. Component assembly in accordance with claim 26,
characterized in that
a nut element is screwed onto the thread of the shaft part and has a radially extending flange which has, at its end face remote from the rivet bead, an engagement surface for a screwing tool and, around this, a ring-like surface for a plunger of a setting head and, at its end face (160) confronting the end face (139) of the bolt element, or at the free end of a circularly cylindrical part (114) provided there, contacts

the end face (139) and is preferably dimensioned in diameter to be larger than this end face (139), i.e. overlaps it.

28. Component assembly in accordance with claim 26 or 27, characterized in that
the projection has a peripheral shape which serves as a projection providing security against rotation for a cable shoe.

29. Component assembly in accordance with any one of the claims 26 to 28,
characterized in that
a cable shoe is located between the nut element (162) and the bolt element.

30. Component assembly in accordance with any one of the claims 26 to 28,
characterized in that
it is provided with a protective coating, not however in regions of the nut element and the bolt element which contact one another.

31. Component assembly in accordance with any one of the claims 17 to 30,
characterized in that
the conical region (16; 116) of the functional element (10; 110) extends over at least substantially the full sheet metal region (42; 142) which is in contact with the functional element after riveting of the functional element to the sheet metal part.

32. Method for the attachment of a functional element in accordance with any one of the claims 1 to 16 to a sheet metal part (40; 140) or for the

manufacture of a component assembly in accordance with any one of the claims 17 to 31,
characterized in that
a conical recess (42; 142) is manufactured in a sheet metal part (40; 140) the cone angle (α) of which corresponds at least substantially to the cone angle (α) of the conical surface (16; 116) of the functional element, with a hole (44) being provided in and concentric to the conical recess (42; 142) with the diameter of the hole corresponding at least substantially to the diameter of the rivet section (20; 120) of the functional element or being somewhat larger than this; in that the rivet section (20; 120) of the functional element (10; 110) is passed through the hole (44) of the conical recess (42; 142) of the sheet metal part so that the conical region of the conical recess (42; 142) enters approximately into contact with the conical surface (16; 116) of the functional element and in that a rivet bead (50; 150) is formed of material of the rivet section (20; 120) which clampingly receives the smaller end of the conical region of the sheet metal part.

33. Method in accordance with claim 32,
characterized in that
the formation of the ring bead (50) takes place by displacement of a region of the rivet section (20) of the functional element (10) and in that the sheet metal material of the sheet metal part (40) is supporting during this displacement in a die which brings the sheet metal material in the conical region into engagement with features of the functional element providing security against rotation.

34. Method in accordance with claim 32,
characterized in that

the ring bead (150) is formed by beading over the rivet section (120) and in that the sheet metal material is supported in a die during or after the beading over which brings the sheet metal material in the conical region (140) into engagement with features of the functional element providing security against rotation.

35. Method in accordance with claim 32,
characterized in that
for the formation of the conical recess in the sheet metal part the sheet metal parts supported on the die is pierced by the free end of the cylindrical rivet section (120) of the element and is formed into a conical recess in a correspondingly shaped cut-out of the die.

36. Method in accordance with claim 35,
characterized in that
for the formation of the stamped slug (161) and of the rivet bead (150) pressure is exerted on a ring-like pressure surface at the free end face of a flange part (164) of a nut element (162) screwed onto the bolt (110).